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VERNAL PHENOMENA IN THE ARID REGION.

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IT has recently[1] been laid down by Dr. C. H. Merriam that "the northward distribution of terrestrial animals and plants is governed by the sum of the positive temperatures for the entire season of growth and reproduction," and that "the southward distribution is governed by the mean temperature of a brief period during the hottest part of the year." Dr. Merriam further explains that, "in computing the sum of the positive or effective temperatures, a minimum temperature of 6° C. (43° F.) has been assumed as marking the inception of the period of physiological activity in plants, and of reproductive activity in animals." Let us now consider the facts as observed at Mesilla Park, New Mexico (altitude 3800 feet), and then discuss their bearing on Dr. Merriam's theories. From the meteorological data collected by observers at the Mesilla Park Experiment Station, I have selected the following as illustrative:

	Mean Temperature (F.).		Maximum Temperature.		Minimum Temperature		Precipitation (Inches).	
	1893.	1896.	1893.	1896.	1893.	1896.	1893.	1896.
January	43.4	41.4	73	71	10	9	.07	.31
February	44.5	41.5	71	75	14	10	1.26	.11
March	50.6	50.5	87	89	21	15	.01	.00
April	58.5	52.3	91	87	29	23	.00	.11
May	62.6	67.0	93	101	33	31	.77	.10
June	77.3	76.8	105	104	46	46	.00	1.01

The following are the latest dates on which the thermometer fell to 30° F. during six years:

1893. 30° on April 29.
1894. 30° " " 2.
1895. 30° " " 3.
1896. 29° on April 20 (23° on April 17).
1897. 29° " " 10.
1898. 29° " " 4.

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[1] Life Zones and Crop Zones of the United States, 1898, *National Geographic Magazine*, December, 1894.

The mean temperatures, even in January and February, are high enough to stimulate growth *in those plants which have been introduced from more humid regions*, but *the native vegetation remains backward, notwithstanding the warmth.* The introduced fruit trees at Mesilla Park, many of them, bloom early and have the flowers or fruit annually destroyed by frost. Mr. F. Garcia has kindly given me the following illustrative data:

Kelsey plum	blooms	March 5–11.	Bidswell Late peach	blooms	March 5–7.
Huanhume plum	"	Feb. 19, 20.	Peento peach	"	March 5, 6.
Bungoune apricot	"	Feb. 19, 20.	Foster peach	"	March 16–22.
Moorpark apricot	"	March 8–10.	Elberta peach	"	March 17–22.

The two last-mentioned peaches do not always fail.

There is one native flower which is earlier than any of the above fruit trees, namely, *Sophia halictorum* Ckll. I have found this in bloom as early as January 31, and it is not injured by the subsequent frosts.

This year (1898) Miss Ivah R. Mead made some studies of the life of the tornillo or Pluchea zone at Mesilla Park, which she submitted as a thesis for the degree of B. S. at the New Mexico Agricultural College. The following observations were made by her on a small selected area of the zone in question:

March 12. Everything seemed dead, all that I could find being two tiny plants less than 3 cm. high. These plants were sprouts growing from perennial roots.

March 29. Ten species of plants were found growing; six were too small for identification; the greatest heights of any of the others were:

Pluchea borealis	10 cm.
Gutierrezia sarothræ	15 cm.
Sophia halictorum	9.5 cm. (just beginning to flower).
Sphæralcea lobata	11 cm.

All were perennials or biennials, except the *Sophia*. The cottonwood trees (*Populus fremonti*) were in bud. The mesquite (*Prosopis glandulosa*) and tornillo (*P. pubescens*) showed no signs of life.

April 5. Grass getting quite green. The grass in protected places under the tornillo bushes is doing much better than in the open places.

April 12. Two cottonwood trees in flower. The tornillo bushes still show no sign of life. *Sophia halictorum* is ripening its seeds.

April 23. Tornillo still dormant. *Lycium torreyi* is quite green. A bush of *Atriplex canescens* in full leaf.

April 25. Mesquite bushes show the first tiny green leaves, but tornillo still dormant. *Lycium torreyi* shows the first blossoms.

April 28. One tornillo bush showed signs of life.

By May 11 the mesquite was in full leaf, as also the cottonwood. *Lycium torreyi* was in fruit, but the berries were still green. By May 18 all the tornillo bushes were in full foliage, and the mesquites were flowering.

Miss Mead's notes are considerably more detailed than the above extracts, but it hardly seems necessary to quote them in full. Speaking generally, the facts are these: With one or two exceptions, the native vegetation is backward, notwithstanding the warm weather; *but after the period of the latest killing frosts it comes out with remarkable rapidity*, and a couple of weeks mark the change from barrenness to verdure. At Mesilla Park the domestic honeybee is abroad more or less even in January, but the native bees behave like the native vegetation. That is to say, they do not appear at all until late in March; but then come on very *rapidly*, so as to be very numerous in species and individuals early in April. In 1894 the first bees in this vicinity were taken on March 26, at Little Mountain; but this is above the cultivated area and is warmer than it, the cold air settling in the bottom land. On April 9, however, bees were abundant at the plum blossoms at Mesilla Park, the genera Osmia, Nomada, Synhalonia, Podalirius, Anthidium, Andrena, Prosapis, Halictus, and Agapostemon being represented. At the beginning of May the willows were in flower and attracted various bees.

In 1896 I took two specimens of *Halictus pruinosus* Rob., at Mesilla Park, as early as March 18, and this is my earliest date for a wild bee in that locality. By way of contrast with the above, we may now consider the state of affairs in Washington State. The following meteorological data have been kindly furnished by Mr. G. N. Salisbury, of the Weather Bureau, at the request of Mr. T. Kincaid:

(1) Average temperature (F.):

	TATOOSH ISLAND (CAPE FLATTERY).	SEATTLE.	KENNEWICK.
January	41.7	40.6	23.2
February	41.8	41.0	34.2
March	45.8	44.6	51.3
April	47.2	48.5	54.5
May	51.7	55.0	64.3
June	54.3	59.9	70.0

(2) Average precipitation (inches):

	TATOOSH ISLAND.	SEATTLE.	KENNEWICK.
January	12.73	4.80	1.54
February	8.50	3.41	0.42
March	9.14	3.42	0.30
April	7.36	4.01	0.39
May	4.58	2.65	0.50
June	4.04	1.35	0.49

Tatoosh Island has 233 cloudy days in the year, Seattle 159, and Kennewick 58. Of these localities, the first two belong to the excessively humid coast belt; the third is east of the coast range and partakes more of the characters of the arid region. It will be seen at once that the moist region has a comparatively warm winter but a cool summer; the difference between the mean temperatures of January and June being from 13° to 20° F. The inland region, on the other hand, has a colder winter climate, and a considerably hotter summer, with nearly 50° difference between January and June. Comparing the average temperatures at Mesilla Park with these, we find that the first two months nearly agree with those at Seattle, the last four much more nearly with those at Kennewick.

Yet the season at Seattle is ahead of that at Mesilla Park, so far as flowers and wild bees are concerned. Mr. T. Kincaid wrote me from thence on March 13, 1898:

"The willows are now blooming, as well as several other plants, such as *Rubus spectabilis, Nuttallia cerasiformis, Ribes sanguineum,* etc. Only a few species of bees have appeared so far."

Mr. Kincaid sent me a series of *Andrena perarmata* Ckll., taken at Seattle on March 15 and 16; while Mr. Dunning (*Canad. Entom.*, 1898, p. 269) reports Seattle specimens of this species taken from February 16 to March 14. Many other facts of this kind will doubtless be published by Mr. Kincaid, who is studying the bees of his region.

I do not know when the bees first fly at Kennewick, but it is probably later than at Seattle, for the same reasons that affect the Mesilla Valley.

So much for the facts; how do they affect the theory set forth at the beginning?

It appears to me that throughout the arid region, where the sky is clear and the radiation great, *the development of plants and insects is controlled largely by the distribution of frosts throughout the year.* By a process of natural selection the native species (except such as are frost-proof) have learned not to appear or develop until the danger of frost is over. That this tardiness is not due to lack of warmth *per se*, is shown by the fact that introduced plants, such as the fruit trees, rush into bloom and get nipped in consequence. In the cloudy Seattle region it is very different. The climate is more uniform, and there is much less danger of frosts following warm weather. Consequently, both bees and flowers appear early.

The climate of the arid region is thus peculiar and presents a barrier to the ingress of plants and animals from without. For tropical and subtropical species the winters are too cold; for species of moist temperate regions the late frosts following warm spells are usually destructive. It is a curious anomaly that, in a locality having more than tropical summer temperatures, fruits of the temperate zone should fail on account of frost!

Fortunately for the horticulturist, we already know many good late varieties of fruit trees, which escape even the latest frosts at Mesilla Park. But there can be no doubt that the true path to success will be that of selection, and the origination of new and specially adapted varieties; that is to say, man will have to imitate, in as short a while as he can, the process of nature in the case of the native productions. When he has accomplished this, he will reap the full benefit of the many excellent qualities of the climate, the dryness, sunshine and warmth, with moisture under control through a system of irrigation.